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Greenhouse gas emission reduction perspectives in the Baltic States in frames of EU energy and climate policy

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ABSTRACT

The goal of this paper is to estimate the perspectives of the Baltic States: Estonia, Latvia and Lithuania on meeting the new European Union climate commitments, i.e., to reduce greenhouse gas emissions by 20% to the year 2020 in comparison with 1990. This ambitious target could be reached based on other EU climate and energy package commitments: increase of the share of renewables and improvement of energy efficiency as tools for fulfilling the GHG emissions reduction target.

The paper gives an overview on the current situation and future plans of the Baltic States in the field of energy efficiency, consumption of renewables and reduction of GHG emissions.

Contents

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1. Introduction

In December 2008 the European Parliament adopted a set of legislative documents (the so called EU climate and energy package) for transforming Europe gradually into a low-carbon economy and increasing energy security. An agreement has been reached on legally binding targets, by 2020:

- to cut GHG emissions by 20% compared to 1990
- to establish a 20% share for renewable energy in final energy consumption and the share of biofuels up to 10% in transport fuels, and
- to achieve a 20% reduction in energy consumption by 2020 (to improve energy efficiency).

Regarding the reduction of GHG emissions, the package contains an offer to go further and commit to a 30% cut in the event of a satisfactory international agreement being reached [1].

Directive 2009/28/EC sets legally binding targets for each EU member state, in order to reach the EU aggregated target of a 20% share of renewable energy by 2020. It creates cooperation mechanisms for achieving the targets in a cost effective way. Several administrative barriers and other burdens will be removed, confirming the 10% target for renewables in transport, and biofuels sustainability criteria are fixed to ensure that only those biofuels are supported that have no negative environmental impact. The directive also has implications for small-scale emitters in sectors such as transport, buildings, agriculture and waste. By 2020, emissions from these areas are to be reduced by an average of 10% compared to 2005, divided between Member States according to differences in GDP per capita. National targets were set for member States, together with a linear legally binding trajectory for the period 2013–2020 with annual monitoring and compliance checks [2].

Directive 2009/31/EC establishes a legal framework for the environmentally safe geological storage of carbon dioxide (CO_2) to contribute to the fight against climate change [3].

Directive 2009/30/EC provides a set of binding targets for the emissions from the fleet of new cars which is an important tool for meeting emission targets in the non-ETS sectors. The directive sets targets to ensure that emissions from the new car fleet are reduced to an average of 120 g CO_2/km. The long-term target is set to 95 g CO_2/km to be reached by 2020 [4].

Decision 406/2009/EC lays down the minimum contribution of EU member States to meeting the GHG emission reduction commitment of the Community for the period from 2013 to 2020 for GHG emissions covered by this decision, and rules on making these contributions and for the evaluation thereof [5].

2. Background

2.1. Overview of Estonian energy sector

In Estonia the domestic fuels play an important role in energy supply. The share of these fuels in the primary energy balance has remained at the level of 65–75% during the last decade. Estonia is the only country in the world to use oil shale as its major primary source of energy. Estonian oil shale as a fuel is characterised by high ash (45–47%) and sulphur (1.5–1.7%) content, low net calorific value (8.3–8.7 MJ/kg) and high content of volatile matter in the combustible part (up to 90%) [6]. Wood is another important primary energy resource: more than half of the territory of Estonia is covered by forest. The third important indigenous fuel is peat. Estonia's dependency on imported energy sources was 21.2% in 2009 [7] Estonia has no oil-refining capacity, and therefore all petroleum products are imported to Estonia, mainly from Lithuania, Finland and Russia. Nevertheless, Estonia has a long term experience of processing oil shale into shale oil – a liquid fuel, which is the only locally produced liquid fuel. Estonia has no indigenous natural gas, so it is fully dependent on imports of natural gas from Russia. In total primary energy consumption, the share of fossil fuels is very high, approximately 90%.

The Estonian electricity sector is well developed and mainly organised around Eesti Energia AS which is a state – owned company engaged in power generation and sales throughout the country. There are also some privately owned companies in the market dealing with generation as well as with the distribution of electricity (small-scale combined heat and power generation, mini hydro and wind turbines). In total, the power plants of Eesti Energia AS generate approximately 91% of the electricity in Estonia [8]. Estonia has always been a net exporter of electricity, mainly to Latvia, but also to Finland, Russia and Lithuania. The only time when import exceeded the export by 82 GWh was in 2009.

The structure of primary energy supply in Estonia is shown in Fig. 1.

In 2009, the primary energy supply totalled about 199.8 PJ in Estonia. The major part (81%) of it was utilised in conversion processes. Approximately half (51%) of the converted primary energy was used for electricity generation, and the rest for heat production (24%) and manufacturing secondary fuels, mainly shale oil and peat briquettes (25%). 8% of primary energy was utilised in the energy sector, including the use for non-energy purposes and transmission and transportation losses. About 11% went directly to final consumption [8].

In Fig. 2 final energy consumption by sectors is presented. The biggest energy consumer is households sector – 45%,

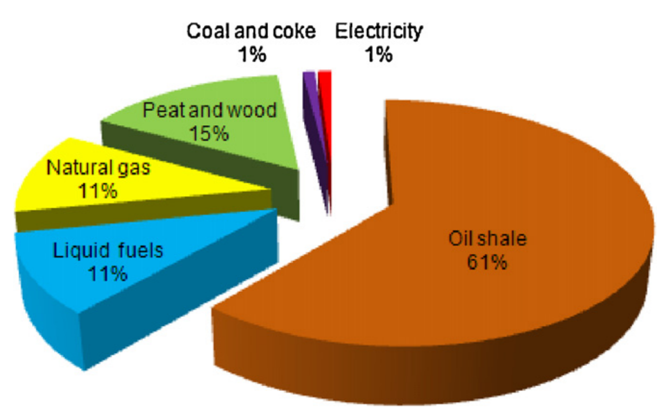


Fig. 1. Primary energy supply in Estonia, % [8].

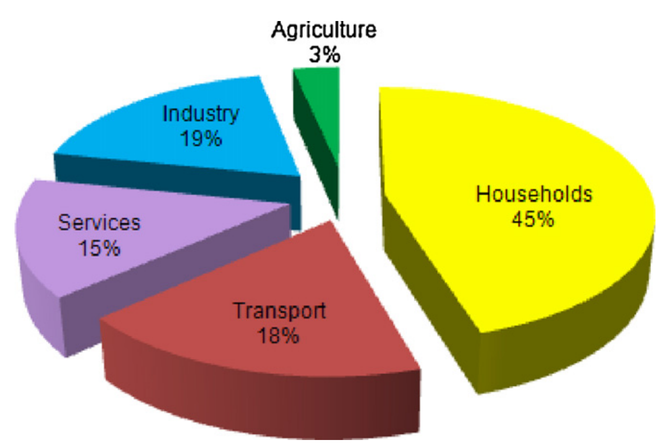


Fig. 2. Final energy consumption in Estonia, % [8].

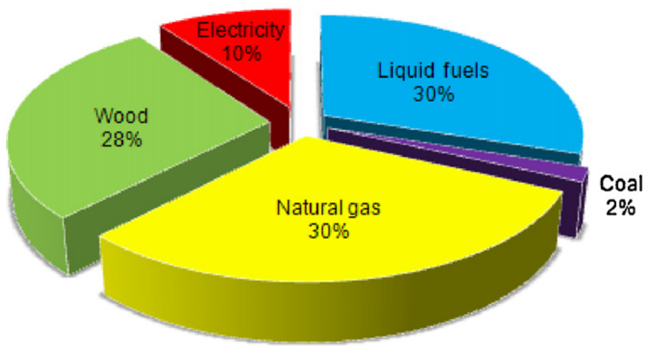


Fig. 3. Primary energy supply in Latvia, % [10].

manufacturing industries, transport and service sectors consume respectively 19%, 18% and 15% and agriculture only 3% of the final energy consumption.

2.2. Overview of Latvian energy sector

Latvia is dependent from imported fossil energy resources and electricity. The most significant domestic energy sources utilised are wood and hydro energy (Daugava Hydropower Plants (HPP) Cascade), but only 29.6% of total energy consumption is covered by these energy resources. Coal, oil products and electricity are imported from different countries (Lithuania, Estonia, Russia), but as in Estonia, there is only one supplier of natural gas – Russia [9].

Within the EU, Latvia has the largest share of renewable energy in its energy mix. Renewable energy sources made up to 36.2% of gross energy consumption in Latvia in 2009. Wood and water are the most widely used renewable energy resources: wood as fuel is used for district heating and heating individual buildings. The share of renewable energy resources in electricity generation is very significant: electricity generation is predominantly based on hydro energy [10]. This electricity comes from three leading hydropower plants in Latvia: the Kegums HPP, Plavinas HPP and Riga HPP. But the volume of electricity generation depends directly on the flow in the River Daugava [11].

The dominant electricity company is the state-owned Latvenergo AS, which imports and generates electricity and controls more than 90% of installed generation capacity, with the balance shared amongst more than 200 small electricity producers. In 2009, Latvenergo AS generated 67% of total electricity supply, 10% was purchased from small electricity producers whilst 23% was the net electricity imports [12].

The structure of primary energy supply in Latvia is shown in Fig. 3.

In 2009, the total primary energy supply was about 189 PJ in Latvia. The domestic primary energy production consists mainly of renewable energy: electricity from hydropower plants and fuel wood combustion for heat and electricity production.

The biggest of energy consumers are households, 38% of final energy is consumed by households. 26% of energy is consumed by the transport sector. Fig. 4 shows the final energy consumption by sectors.

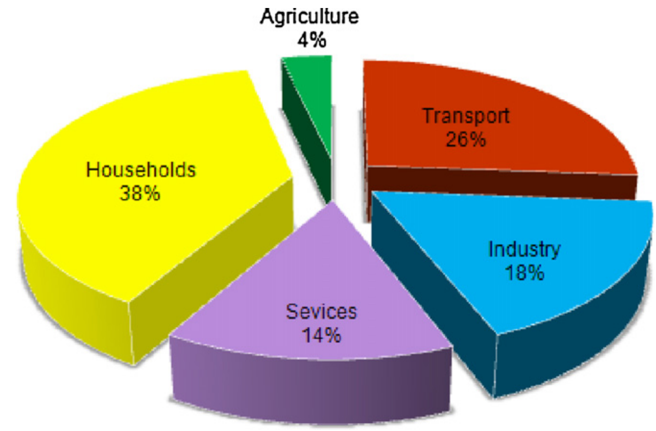


Fig. 4. Final energy consumption in Latvia, % [10].

2.3. Overview of Lithuanian energy sector

The closure of Ignalina nuclear power plant (NPP) marked a turning point for the Lithuanian energy sector. After shutdown of Ignalina NPP in the end of 2009, Lithuania became dependent on energy and electricity import. Natural gas consumption in its energy mix has increased for the production of electricity (Lithuania is totally dependent on natural gas imported from Russia) and the electricity price for customers has increased by more than 30%. Against the background of the economic and financial crisis, the closure of Ignalina NPP is an additional factor, which has affected Lithuania's economic development: the closure of Ignalina NPP alone has reduced Lithuania's GDP growth by at least 1% in 2010. The biggest risk for Lithuania after the closure of Ignalina NPP is the increased dependency on energy imports [13].

The closure of Ignalina NPP led to the revision of Lithuania's national energy policy. It is clear that the closure strengthened the development of other energy infrastructure projects in Lithuania, but Ignalina NPP is not the only reason for these changes. The Baltic Energy Market Interconnection Plan (BEMIP), endorsed on 17 June 2009, is another essential factor for further driving of energy infrastructure projects. The BEMIP, an initiative of the European Commission with 8 participating Baltic Sea countries, is an unprecedented step in the EU energy policy. It creates an energy policy agenda both for generation and interconnection for the Baltic Sea region. The plans to build a new nuclear power plant (Visaginas NPP) together with Latvia, Estonia and Poland in 2020 seem quite real as a strategic investor will be selected in 2011 [14].

2010 was the first year without nuclear power in Lithuania. Currently more than half of the electricity has to be imported. In the field of renewable energy resources Lithuania seeks to achieve the 23% target of renewable energy in the final energy consumption to 2020. This means for the electricity sector that at least 20% has to be covered by renewables. For this purpose, a clear framework and economically most feasible technical solutions should be helpful. In particular, Directive 2009/28/EC has fixed a renewable energy target for electricity of 7% of gross electricity consumption by 2010 [2].

The amount of electricity generation in 2010 has decreased to 4.71 TWh (2009: 13.5 TWh) that means a change of minus 65.1%. About 6 TWh had to be imported, mostly from Belarus (4.09 TWh) and also from Latvia (2.82 TWh) whilst a small amount (0.92 TWh) has been exported to Russia. In 2010 the total Lithuanian electricity demand was covered by fossil fuels for 52% and about 16% (9.6% of the consumed energy) by renewable sources. We have to consider the fact that in 2009 74% of the electricity mix was nuclear power. In particular, the increase of renewable use is only relative and therefore mostly related to the NPP shut-down. For the Lithuanian electricity system, 62% of import was necessary for covering total electricity demand. Lithuania had to import 2–3 times more electricity than any other deficit power system in the EU. Today, Lithuania's most important energy sources are natural gas and oil, each 42%, the full amount out of these sources comes from Russia [15]. Fig. 5 shows primary energy supply in Lithuania in 2009.

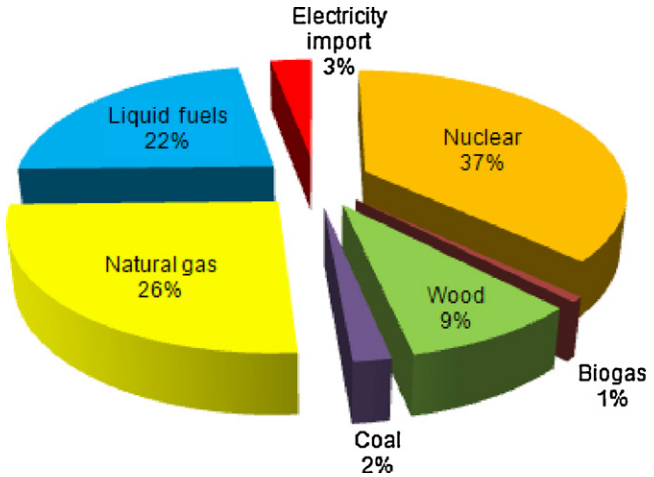


Fig. 5. Primary energy supply in Lithuania, % [3].

The domestic resources represent only about 10% of the primary energy supply of Lithuania.

In 2009, the total primary energy supply was about 356 PJ in Lithuania. The domestic primary energy production consists of nuclear power and renewable energy, including electricity from hydro and wind power plants and fuel wood for heat and electricity production.

The largest energy consumer is the transport sector. 34% of final energy is consumed by this sector and 31% by the household sector. The share of industry is 18% of total final energy consumption. The final energy consumption by sectors is shown in Fig. 6.

Moreover, Lithuania has one of the highest levels of energy intensity amongst the economies in transition. In comparison with the neighbouring Latvia, Lithuanian industry consumes more energy. In recent years, the increase of efficiency in energy consumption has been hampered not only by the limited financial resources, but also by the modest support of the state. In terms of energy intensity and the amount of energy used for producing a unit of GDP, Lithuania is one of the most vulnerable countries in the EU.

2.4. Energy and climate related targets and obligations for the Baltic States

The main climate and energy related targets set in various legal acts of the EU for Estonia, Latvia and Lithuania are listed in Table 1.

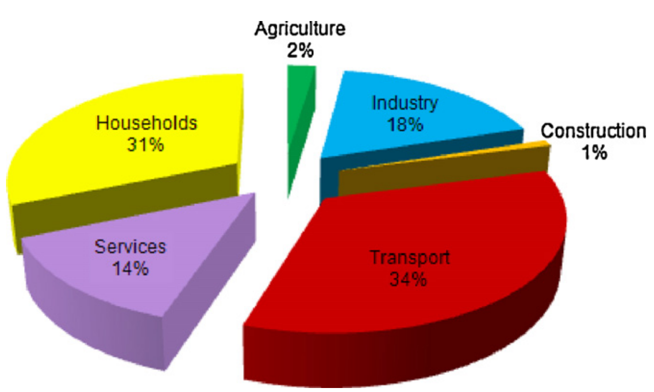


Fig. 6. Final energy consumption in Lithuania, % [15].

Table 1
Renewable energy and climate related targets to the year 2020.

	Estonia	Latvia	Lithuania
Share of RES in the gross final energy consumption [2]	25%	40%	23%
Share of RES in the use of transport fuels [2]	10%	10%	10%
Final energy consumption[a] [16–18]	−11%	−14.5%	−17%
Limit for the non-ETS GHG emissions (compared to 2005) [5]	+11%	+17%	+15%

[a] Final energy reduction targets: for Estonia: 11% in comparison with 2010, for Latvia: 14.5% in comparison with 2008 and for Lithuania: 17% in comparison with 2009.

3. Energy efficiency

3.1. Estonia

In Estonia the efficiency of primary energy utilisation (the ratio of final energy consumption to the primary energy used) is approximately 52% [8], which is lower than in the neighbouring countries. The main factor here is that over 90% of electricity in Estonia is produced in condensing power plants [8]. The efficiency of these plants is very low, approximately 36%. Other factors, like high losses in the electricity and district heating networks, large export volumes of converted energy, also have an impact.

Much work has been done in the field of energy efficiency in Estonia. A national goal has been set to achieve the continuous improvement of energy efficiency in both the energy conversion and energy end-use sectors. In 2009 the Parliament of Estonia approved the National Development Plan of Energy Sector until 2020 [19]. The Plan foresees that in order to ensure sustainable energy supply and consumption, energy efficiency shall be improved by energy producers, transporters and consumers and the share of renewable energy sources and combined heat and power production (CHP) shall be increased in the energy balance. Upon the development of sustainable energy supply and consumption, the awareness of the public of the possible solutions and innovative technologies shall be increased and implementation of new solutions shall be promoted.

To attain the objectives of improving energy efficiency, the Energy Conservation Target Programme for the period 2007–2013 has been drawn up.

In 2005 oil shale formed 45% of the internal (i.e., excluding energy export) energy balance of Estonia. Such a large share of one fossil energy source in the country's energy balance is considered not reasonable due to energy security as well as climate considerations. Therefore, it is envisaged to increase the share of other energy sources in the energy balance and to establish the infrastructure for more extensive energy trading with other EU Member States. However, the oil shale power industry shall be developed in order to ensure the security of supply.

Regarding the electricity sector, the Plan sets a target to expand the use of CHP up to reaching the share of 20% of gross electricity consumption by 2020. The relevant schemes of operational support for CHP have been introduced. Also, it is foreseen to reduce the losses in power lines: below 3% in distribution networks and below 6% in the transmission grid.

From the end of the year 2006, a connection has been established with the Finnish energy system through a 350 MW underwater cable Estlink. The new connection increased Estonia's reliability substantially and enables now to export electricity produced in Estonia to the Nordic countries. The construction of the next interconnector (650 MW) between Estonia and Finland – Estlink 2 – is on-going and it is expected to be in operation in 2014.

In order to restrain the increase of energy consumption, it is important to increase the efficiency of the energy system and

energy conservation at end consumers, especially in the heat sector, which has the highest potential for energy conservation. Estonian energy networks have become more efficient: thermal energy losses upon transmission and distribution have decreased by 23% and power energy losses by 28% compared to 2000 [8]. This progress has been achieved by the development of regulation, increased energy prices and sufficient investment capacity of undertakings.

3.2. Latvia

The efficiency of primary energy utilisation in Latvia is approximately 90%. It is much higher than in other countries of the EU. The main reason for that is the fact that significant part of consumed electricity is produced in hydropower plants. Besides, electricity is produced in Riga power plants (TEC 1 and TEC 2) which are partly operating in CHP mode.

The main problems of energy efficiency in Latvia are related with low energy efficiency in the residential and public sectors.

Many energy efficiency measures with positive results have already been undertaken in Latvia. The most effective measures were taken for improving the energy efficiency of buildings and heat supply: replacement and modernization of heating networks, improvement of the heating efficiency of public buildings, installation of more efficient boilers [20].

The government has established a long term vision for Latvia's energy policy through the adopted Guidelines for Energy Sector Development for 2007–2016 [21]. Promotion of energy efficiency has been included in these Guidelines as one of the key priorities for the energy sector development.

According to the requirements of Directive 2006/32/EU [22], Latvia has adopted the First National Energy Efficiency Action Plan (the Plan) for 2008–2010, which includes energy efficiency measures in different sectors showing that the most important actions have to be taken in the household sector [20]. Pursuant to the Plan, various measures are supposed to be realised in Latvia in the residential, industrial and service sectors. The national energy saving target (12.54 PJ) for the period 2008–2016 was calculated. Various measures have been taken in the frame of the Plan: investments in municipal buildings, apartment buildings and district heating systems to increase energy efficiency. The calculations made by the Ministry of Economic Affairs show that during the period 2008–2009 the energy savings in final consumption were 12.30 PJ [23]. The calculations were made taking 2007 for the base year in accordance with the EC requirements.

The new Energy End-use Efficiency Law was adopted in 2010 where the conditions for the development and promotion of a market for energy efficiency services have been defined [24]. According to this law, the Second National Energy Efficiency Action Plan for 2011–2013 was prepared. At the moment this plan is under consideration in the Cabinet of Ministers. The plan includes the measures only for energy end-use efficiency, not for the transformation sector. According to this document, by 2020 the energy savings in total final consumption compared with the base year 2007 should reach 21.78 PJ [25].

3.3. Lithuania

The efficiency of primary energy utilisation in Lithuania is approximately 53%. Although the intensity of primary and final energy consumption has decreased approximately 50% in Lithuania during the period 1996–2009, the energy intensity per unit of GDP is 2.7 times higher than the EU average. This reveals vast untapped potential for energy efficiency, especially in the heating and transport sectors [26].

The positive trends of energy intensity reduction have changed since 2009, because during the crisis of 2007–2009 the energy consumption went down, but for several sectors (services, households, etc.) the energy consumption is less flexible and it has reduced less than GDP. The most energy intensive sectors were the transport and economy sectors [27].

The main policy document to promote energy efficiency in Lithuania is National Energy Efficiency Programme for 2006–2010 approved by the Government in 2007. It sets the following targets: renovation of buildings and updating their energy facilities, increasing energy efficiency of energy production and use in all sectors. Implementation of the Energy Efficiency Action Plan [26] provides for final energy savings up to the amount of 3.9 PJ (1092 GWh)/year in 2010 2.6 PJ (726 GWh/year with earlier actions excluded) and 17.0 PJ (4725 GWh)/year in 2016. This target corresponds to the National Energy Strategy target – starting from 1 January 2008 to achieve 9% of final energy savings during the period of 9 years, compared with the final energy consumption level of 2005. Separate policies and measures are foreseen in the specific sectors of economy. The energy saving targets has been set for specific sectors as well.

According to the National Green Procurement Implementation Programme, the public institutions shall apply environmental criteria for public procurements; at least for 10% of all executed procurements in 2008, 15% in 2009, 20% in 2010 and 25% in 2011. Institutions can choose environmental criteria from the approved list, which also contains the energy efficiency criterion [28]. The Lithuanian Government order for mandatory inclusion of energy efficiency criteria in public procurement was approved in 2008. According to this order, the public institutions shall set minimum efficiency requirements in technical specifications.

In addition, the reduced 9% rate of VAT is applied to the supplies of services related to the construction, renovation and insulation of residential buildings, which are financed from the state and municipal budget resources or with soft credits granted by the state and resources of special state funds.

The Programme of Modernization of Multi-flat Buildings has been an excellent instrument to gain energy intensity decrease in the household and construction sector [27]. The economic crisis had the most painful impact on the construction sector resulting in its shrinkage. Therefore the adequate financing of the renovation of multi-flat buildings would provide for double benefits: recovering of the construction sector and energy intensity decrease in this sector as well as energy intensity decrease in the rest of economy sector. Although Lithuania is currently experiencing some problems with the implementation of Energy Efficiency Action Plan. Main problems are related with the implementation of energy saving targets set for the household sector where the Programme for Modernization of Multi-flat Buildings had failed.

The new financing scheme implemented by the Government with a 50% support of investments instead of 25% would have positive impact on energy savings in the household sector [28]. Other sectors are performing quite well and Lithuania will not face many problems with the requirements set by the EU Energy and Climate Package for energy efficiency improvement to 2020.

3.4. Summary of the Baltic states

For comparing the energy efficiency levels, both within a country during a time period and between countries, several indicators can be calculated. The most general macro level indicator used for characterizing the overall energy efficiency in a country is the primary energy intensity of GDP, which relates the total amount of primary energy used in a country to GDP at constant prices. This

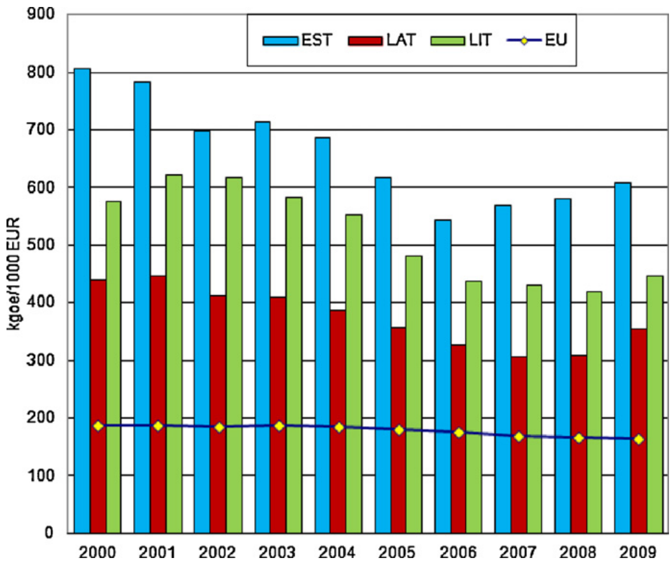


Fig. 7. Primary energy intensity of GDP (EUR CLV2000).

indicator represents both the efficiency in the energy transformation sector and that at final consumers.

According to the latest Eurostat data, the average primary energy intensity in the EU was 3.6 kg oe/1000 EUR in 2009. The corresponding indicators for Estonia, Lithuania and Latvia were 3.6, 2.7 and 2.2 times higher. The lowest level of energy intensity in Latvia can be explained by the fact that electricity in Latvia is produced mostly in hydropower plants and in power plants that partly are operating in CHP mode. The main reason for the high level of primary energy intensity in Estonia is that over 90% of electricity in Estonia is produced in condensing power plants.

The ratio of energy supply to GDP is improving in all three Baltic States: Estonia, Latvia and Lithuania. The lowest value was achieved in 2006; the small increase in the last years was caused by the economic depression (see Fig. 7).

4. Renewable energy consumption

4.1. Estonia

The use of renewable energy sources in Estonia has been increasing since 1990. The changes of the share of renewable energy sources in gross final energy consumption are shown in Fig. 8.

In 2009, 36.2 PJ of renewable energy was produced and 30.0 PJ utilised. The share of renewable energy sources in Estonia's energy balance is rather high: in 2009 the share in primary energy production was 20.8% and in gross inland consumption (GIC) 13.5%. In 2000 the woody biomass was the almost only renewable energy source utilised for energy production.

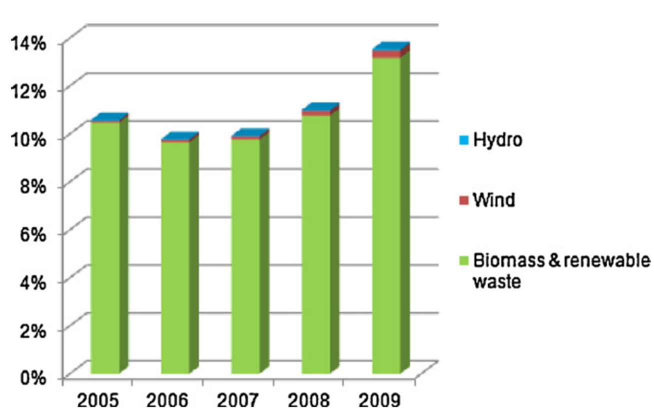


Fig. 8. Share of renewable energy sources in the gross total energy consumption in Estonia, % [7].

The deployment of smaller scale CHP as an element of decentralized energy production strategy would increase the energy supply security in Estonia. Therefore, the potential use of biomass in new CHP plants can be a development option. Up to now, the biomass has been fired in district heating and other heat-only boiler (HOB) plants. Today, woody biomass is more widely utilised in district heating plants. In 2010 there were 833 boilers firing wood as a main fuel. Heat production (1557 GWh) by these boilers made up 30.0% of the total heat production in HOB plants. Firewood is also used by households for heating and cooking purposes, especially in rural areas.

In Estonia, the heat production in HOB plants is relatively environment benign already. Nevertheless, in the Development Plan 2007–2013 for Enhancing the Use of Biomass and Bioenergy [29] a target was set to increase the share of district heat produced from renewable resources in total volume of district heat from 21% in 2005 to 33% by 2013.

Since 2006 the use of wind energy for electricity generation has grown rapidly, reaching 2.3% of the GIC in 2009. Regarding electricity production from other renewable sources, there are tens of mini and micro hydropower plants on Estonian rivers generating a minor quantity (ca 30 GWh a year) of electricity whilst the wind electricity production was 195 GWh in 2009 (277 GWh in 2010). Biomass (woodchips) is utilised in several power plants, in the case of largest plants it is co-fired with oil shale. The new support scheme together with the commissioning of two new CHP plants caused a jump in wood based electricity production from 28 GWh in 2008 to 307 GWh in 2009. In 2009 the total production of renewable electricity reached 541 GWh that makes 6.1% (1046 GWh in 2010, 10.8%) of the gross electricity consumption in Estonia, meaning that the relevant target set by EU (5.1%) for 2010 has been exceeded.

As to other renewable fuels, biogas is produced in small quantities and utilised in some pilot plants. No technical quality standards have been established for gas from renewable energy sources, due to which it is not possible to sell it into the network. Similarly, no legislation regulates the sales of gas from renewable energy through the gas network either. As a result, the produced biogas is consumed for local needs and until today the biogas producers have not shown any interest in the production of biomethane.

Regarding biofuels, Estonia is in difficult situation as the use of biofuels in transport is so small that it is not reflected in the energy balance. In the report presented to the EC it is provided that in 2009 four biofuel operators released 1.75 thousand tons (66.98 TJ) of biodiesel and one operator released 0.16 thousand tons (4.28 TJ) bioethanol to the market. On the basis of energy content, the biofuels constitute 0.26% of the fuel use in transport. The only support to transport biofuels has been the exemption from excise duty since 2005. The excise exemption permit for biofuels from the EC expired on 27 July 2011.

At present, 132 MW of wind power capacity is installed in Estonia, approximately 200 MW of new wind power capacity is being constructed and connection points have been completed for an additional approximately 380 MW. Also, preliminary permits have been given for the installation of 2600 MW of wind power. These projects are still in the planning process. Regarding more extensive use of wind energy, technical limitations are to be considered as the intermittency effects on the grid will need compensating capacity. The results of a special study ordered by Estonia's national grid operator Elering AS from the Danish company Ea Energy Analyses a/s indicated that it is technically possible to further develop wind power in Estonia in the coming years without severe balancing costs. If the expansion of the wind power

capacity is limited by the lack of possibility to curtail wind power and the missing regime for allocating balancing cost to the various stakeholders, the wind power capacity should not exceed 600 MW before Estlink 2 is put into operation and 900–1100 MW after Estlink 2 is in operation. It was estimated that if these limitations are removed, it will be possible to accommodate up to 1200 MW wind power with Estlink 1 and up to 2000–2200 MW with both Estlink 1 and Estlink 2 in operation [30].

The current version of the Electricity Market Act provides that the operational subsidies for new wind based electricity will not be paid if the annual production of wind electricity reaches 600 GWh [31]. In projections of wind based electricity it has to be taken in account as well. Assuming the 1100 MW capacity of wind parks by 2020, the annual production may reach 2–3 TWh, which can reduce the CO_2 emission by 1.9–2.8 million tons, if the fossil based electricity is replaced.

As to technical potential of biogas, approximately 2.1 million tons of manure with the energy content of 400 GWh is generated annually. If half of it could be used for biogas production, this would form approximately 200 GWh of primary energy. In addition, there are 3–4 sewage treatment plants whose capacity allows producing biogas that could remain in use on the spot to meet the local needs. Biogas collected from the existing or closed landfills is used either for the needs of the company or to produce heat for the residential district located in the vicinity. Until today no sufficient resources have been found to produce biogas and sell it into the network in a larger volume. In Estonia, during the full harmonisation of Directive 2009/28/EC the issue of biogas integration into the natural gas network will be revised.

For promoting the use of energy from renewable resources in transport, the following measures are outlined in the National Renewable Energy Action Plan:

- establishment of the 5–7% blended fuel obligation on liquid fuels (by 2015);
- transfer of public transport partially (50%) to renewable energy (by 2020);
- encouraging buyers to prefer environmentally friendly vehicles.

In the frame of Green Investment Scheme, there are plans to take use of the revenue from selling CO_2 emission surplus assigned amounts (AAUs) pursuant to the Kyoto Protocol (Article 17). For example, according to the contract signed with Spain, in Estonia 21 MEUR will be invested in new energy efficient diesel fuelled buses (approximately 100 buses for the public sector) where biofuel can be used too.

4.2. Latvia

According to the Eurostat data, Latvia has the highest share of renewable energy in the gross final energy consumption in the European Union. The changes in the share of renewable energy sources are shown in Fig. 9 [7].

Wood fuel and hydro power are mostly used renewable energy sources in Latvia. Wind energy, biogas, biofuels and straw are used in much smaller amounts. The solar energy sources are neither supported, nor used in Latvia. A few exceptions are some projects implemented within the framework of different programmes.

An energy source dominating in renewable electricity is hydropower. The share of hydropower in the total consumption of electricity produced from renewables was 93.6% in 2010 [32]. Hydropower in Latvia includes two groups. First group is three large-scale hydropower plants on the Daugava operated by Latvenergo AS. These power plants produce approximately 70% of the total electricity volume generated in Latvia. The Kegums HPP installed

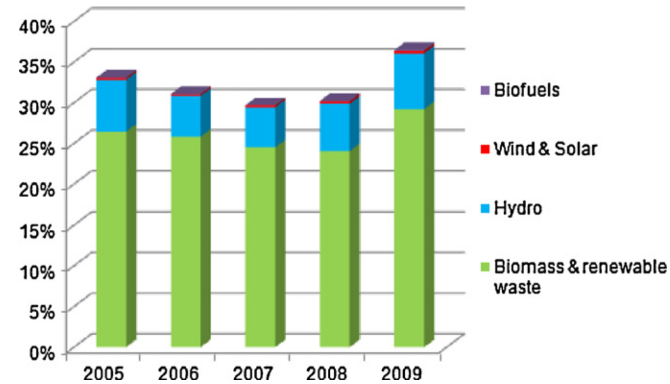


Fig. 9. Share of renewable energy sources in the gross inland energy consumption in Latvia, % [7].

capacity is 240.1 MW, that of Plavinas HPP 883.5 MW and Riga HPP 402 MW [33]. Another group is the small scale hydropower plants. There are 141 small HPPs in Latvia with the total capacity of 26 MW [10,12]. In 2009, these plants produced 66 GWh of electricity. Electricity production in hydropower plants varies strongly along with the natural water supplies.

Latvia has a very good potential for wind energy development alongside the Baltic Sea coastline. The total electrical capacity of installed wind power plants in Latvia was 29 MW at the end of 2009. These plants produced 50 GWh in 2009 and 49 GWh in 2010 [10].

The wind energy potential depends on wind availability in the country. Several studies show that there are three most favourable regions for wind farms in Latvia: a 10–30 km wide breeze zone in Kurzeme (west of Latvia), Kurzeme highlands, Ainaži breeze region with a 15 km zone from the seashore (close to the border with Estonia) [34].

According to the forecast made by Ministry of Economics, the total installed capacity of wind parks will be 416 MW (236 onshore, 180 offshore) in 2020. And according to the assessment presented in the informative report, in 2020 the planned wind power share will make up to 18% of the total electricity from renewable energy sources [32].

At the moment electricity production from biomass is very small in Latvia. There were five biomass fired CHP plants in 2009 with the total installed capacity of 2.95 MW_{el} [33]. But the installation of a new wood-fired CHP plants is planned. In June 2011, there were 29 active licences given by Ministry of Economics for the installation of biomass fired CHP plants with the total installed capacity over 30 MW [12]. The largest wood fired CHP plant in Latvia, which will be installed by the company SIA Graanul Invest, will implement the bubbling fluidized bed technology and use the combination of forest residues, such as bark and wood chips, with milled peat. The capacity of the plant will be 15 MW of heat and 6.4 MW of electricity.

Five biogas power plants with the total installed capacity of 9.1 MW_{el} were also operated in Latvia in 2009. By 2010 six new biogas power plants were installed additionally [33]. According to the Biogas Production and Utilisation Development Programme 2007–2011, the installed capacity of biogas power plants should be about 55 MW by 2011 [35]. In June 2011, there were 59 active licences given by Ministry of Economics for the installation of biogas power plants with the total installed capacity over 13.5 GW [12].

In 2010, heating was dominated by biomass, mainly wood fuel, which comprises 99% of renewable energy sources consumed in the heat supply. The share of heat energy produced using wood fuels was 14.6% [12].

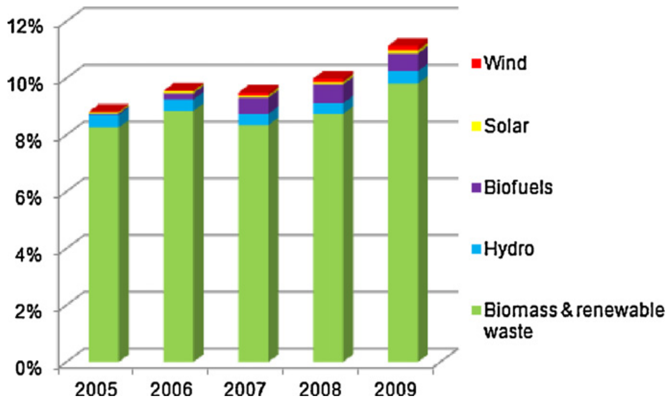


Fig. 10. Share of renewable energy sources in the gross inland energy consumption in Lithuania, %.

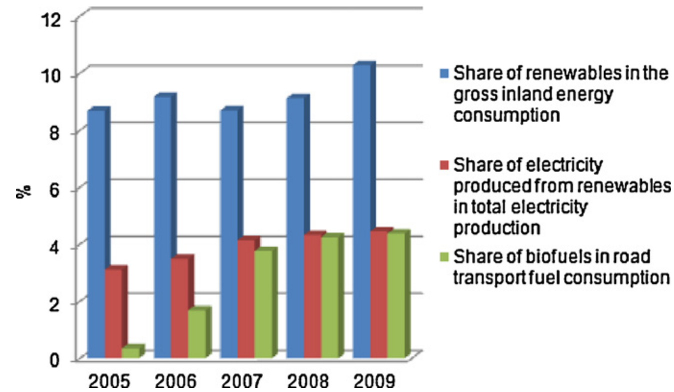


Fig. 11. Development of the use of renewables in Lithuania [15].

There are three main groups of biomass used for heat production in Latvia: wood fuel, straw and agricultural wastes. The most significant group is wood fuel which includes firewood, wood waste and wood products: woodchips and wood pellets. In 2010, 280 boiler houses from 668 used wood as a fuel (140 firewood, 85 woodchips, 11 pellets, 5 wood waste, and 39 mixed biomass fuels). Besides, in 29 boiler houses wood was co-fired with fossil fuels.

The share of straw in heat balance is insignificant–there are only four straw burning boiler houses with the total installed capacity of 5.6 MW operating in Latvia [10].

According to the biofuel production and use in Latvia, this sector is in the development stage. In 2010 two bioethanol production plants and six biodiesel plants were in operation. During a year the share of biofuels in the total amount of transport fuels has risen by 2.48 percentage points to 2.96% in 2010 [36,37]. It can be explained by new amendments in the Cabinet Regulation No. 332 on conformity assessment of petrol and diesel. According to these changes, starting from October 2009, only diesel with biodiesel (obtained from rapeseed oil) content of 4.5–5% by volume of the total quantity of end product is permitted to be sold in Latvia. Additionally, petrol with octane number 95 or higher, but lower than 98, may only be sold if bioethanol content was 4.5–5% (by volume of the sold petrol) [38].

4.3. Lithuania

Lithuania has a scientific, technological and industrial potential for renewable energy development. Despite its small capacity, the renewable energy sector is currently undergoing rapid development. In 2001, renewable energy sector was featured only by wood fuel and hydropower. However, during the past eight years other renewable energy sources have been significantly developed. Wood fuel and wood waste are the most widely used renewable fuels for heating in Lithuania, making up to 90% (the 2009 data). The remaining 13% is other renewables [39].

The biggest renewable potential for electricity production in Lithuania could be considered the hydro and wind energy. It is expected that the usage of biomass in electricity generation will increase nine-fold between 2009 and 2017, whereas the electricity from wind is expected to rise 54 times between 2009 and 2017.

Currently, the share of renewable energy sources in the final energy consumption amounts to around 14%. The largest part of it is covered by biomass, which will continue to play a leading role in the energy production from renewable energy sources. Given Lithuania's natural conditions, the potential of wind and hydro energy is also not fully exploited yet (see Fig. 10).

Electricity generation from renewable energy sources in the energy sector is amongst the state's top priorities. National Renewable Energy Resources Development Strategy has been approved by the Government [40]. The Strategy defines the main objectives for the energy sector, setting national targets for the implementation of strategic initiatives through the years 2020, 2030 and 2050. The main goal of the Strategy is Lithuania's energy independence before the year 2020. It sets a target to increase the use of renewable energy resources in energy sector from 15.3% in 2008 to 23% in 2020. Lithuania will progressively increase the use of renewable energy resources in the production of electricity and heat as well as in the transport sector. The state will aim to reach the target of 23% of renewable energy in final energy consumption to 2020, including no less than 20% of renewable energy in the electricity sector, 60% in the district heating sector and 10% in the transport sector. The major focus is put on the use of biomass in CHP plants and application of wind power. A priority is also put on the full implementation of available hydro energy potential. The state will aim for at least 20% of electricity to be generated from renewable energy sources, mainly in biomass CHP plants and wind power plants. In order to reach this goal, Lithuania will have to install 500 MW of wind energy capacity, 10 MW of solar energy, at least 224 MW of biomass and 153 MW of hydro energy capacity [41].

Renewable energy sources will cover at least 60% of district heating, mainly by unlocking the biomass potential. In this regard, it is very important to ensure the availability of sufficient biomass resources at competitive prices. The infrastructure for collecting wood biomass will be developed, proper management of the flows of wood products provided and the use of straw substantially increased.

The changes of the share of renewable energy sources in gross final energy consumption and electricity production and that of biofuels in the road transport fuels consumption is shown in Fig. 11.

Fig. 11 shows, that the share of renewables has sharply increased since 2005. The use of renewable energy sources in the transport sector has increased especially drastically.

The Law on Electricity provides that the state shall encourage the producers to generate electricity from renewable energy sources by imposing the public service obligations. In addition to these services, it includes the production of electricity from renewable energy sources connected to the electricity networks [42]. In 2008 the Commission approved the new purchase prices of green electricity, applicable from January 1, 2009. The tariffs will be guaranteed until December 31, 2020. However, several barriers exist, like long lead-times for authorisation, environmental impact assessment procedures, and changes in the legal status of land.

The on Excise Duty provides that the exemption from excise duty is applied to electricity produced from renewable energy sources. The provisions dealing with electricity of the Law on Excise Duty entered into force from January 1, 2010 [43].

A new law on the promotion of renewables was adopted in 2010. The law sets a legal basis for the state management, regulation, supervision and control in the use of renewable energy sources in the energy sector. The provisions of the law regulate relationship between the network operators, energy producers using renewable energy sources and public institutions responsible for maintaining the supervision and control of the use of renewables in electricity, heat and fuels production.

There are no policies or funds for the promotion of renewable energy specific to the industry, only general industrial policies. From 2002 onwards, according to the Law on Taxes for the Pollution of Environment, natural persons and legal entities (industry, district heating companies) implementing environmental protection measures that reduce pollutant emissions into the atmosphere from stationary pollution sources for at least 5% calculated from the highest fixed permitted pollution standard, shall be exempt from the pollution charge under the established procedure if the pollutant amount is reduced by 5% [44].

Lithuania has a vast potential of wood-based fuels, as 31% of the country is covered by forest. As a result, the biomass (wood residues, straw, energy plants), is one of the most significant renewable energy sources, which comprises an important part of the domestic fuel supply. This can be estimated as a total wood stock of 378 million m^3, whilst the annual felling volume of wood is 6 million m^3. The consumption of wood fuel and wood waste as a fuel makes around 3.7 million m^3. Wood accounts for 6% of the total energy produced in Lithuania. Most wood fuel is sawmill waste. Lately, forestry has started selling the logging waste and increasing number of boiler operators use it for fuel. The available resource of forest residues is around 1 million m^3. In order to consume this amount in one year, the total capacity of 300 MW boilers would be required [44].

The biofuel penetration has almost doubled between 2006 and 2007. Biofuels are supported through tax exemptions and/or reduction and compensation for raw materials. These measures are potentially sufficient to reach the targets for 2010, but it is not possible to evaluate the impact towards the 2020 targets. They are certainly not sufficient for developing a low carbon economy. There is a lack of legislative framework and coordination, and no incentives for electric transport [45].

Around 1 million tons of industrial and household waste is formed in Lithuania each year. The biodegradable waste compounds make 50% of that amount. Separated biodegradable waste could be used for the production of energy with the annual biogas production potential of 87.4 million m^3 (1.9 PJ). To date, less than 10 biogas power plants operate in Lithuania and recycle city sewer sludge, pig manure and a variety of organic waste. The majority of them use biogas to produce electricity. In 2009 biogas composed only 0.05% of total energy amount produced in Lithuania. This sector has a great potential for the development in the future, especially now when the feed-in tariffs have been approved at EUR 0.086 per kWh tariff and the Lithuanian Association for Biogas has been established [45].

Hydropower resources that are available in Lithuania total 2.7 TWh per year. 8% of the hydropower energy comes from two major rivers – the River Nemunas and River Neris. Currently there is only one large-scale HPP in Lithuania located on the River Nemunas in Kaunas. It has a total capacity of 100 MW and total output of 375 GWh per year. To date, more than 80 small HPP have been already built or are under construction. Their total capacity exceeds 14 MW and production amounts reach approximately 540 GWh of electricity per year. However, only 14% of available hydropower resources are being used. This is only 0.3% of total energy production in Lithuania. There are about 130 possible locations for building or renovating small hydropower plants in Lithuania, with a total possible power production up to 60 GWh per year [46].

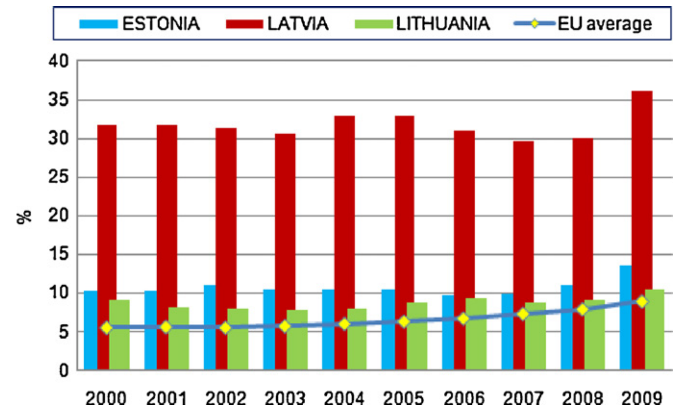


Fig. 12. Share of renewable energy sources in the gross inland energy consumption in Baltic States and EU average, %.

The Government of Lithuania is promoting wind energy, which is one of the cleanest sources for producing electricity. For example, Lithuania participates in a power project aimed at creating proper conditions for efficient development of wind power production in the Baltic Sea region. In 2008, the total capacity of 36 wind power plants that operate in Lithuania was 52.3 MW. The wind based energy production amounts to 1% of the total electricity produced in Lithuania. Lithuania plans to implement off-shore wind power projects in its territorial waters. Unfortunately, the coastline is only 99 km and allocated for various types of use. The Strategic Committee for Energy made a decision that wind power facilities in the sea will be developed starting from 2010 [13].

Geothermal energy in Lithuania is produced from a water basin horizon at the depth of up to 100 m in Klaipėda and Vilnius. In 2009, 9 GWh of geothermal energy was produced in Lithuania amounting to 0.013% of the total energy produced in Lithuania. The geothermal energy for heating private houses can be produced by installing heat pumps. At a depth of 1–1.3 m, the pipes are installed for energy collection. 8% of the required heat energy of households could be produced this way. The geothermal electric energy can be produced from a hot dry rock available only in Western Lithuania at the depth of 2.5–4.5 km.

Lithuania receives 1.0 MWh/m^2 (total: 65 TWh) of solar energy per year. But more than 80% of it is distributed during 6 months: from April till September. There are some small private installations that use the solar energy for their own needs; however, at present there are no large photoelectric power plants operating in Lithuania. Due to Lithuania's geographical location, seasonal, daily, and meteorological changes, it is not expected that a great part of electricity demand would be met from solar electricity [13].

4.4. *Summary of the Baltic states*

Regarding the share of renewable energy in the gross inland energy consumption in each of the Baltic States is very different. Including a large hydro input, Latvia has the highest share of renewable energy in the European Union – 36.2% of energy is produced from renewables. In Estonia and Lithuania the use of renewable energy sources has been increasing since 1990, forming in 2009, 13.6% and 10.5% respectively (see Fig. 12)

5. Greenhouse gas emissions in The Baltic States

The total GHG emissions can be considered in terms of greenhouse gas intensity of the country's GDP.

In Fig. 13 the greenhouse gas emission intensity of economy is presented. Intensity shows the amount of emissions emitted for the

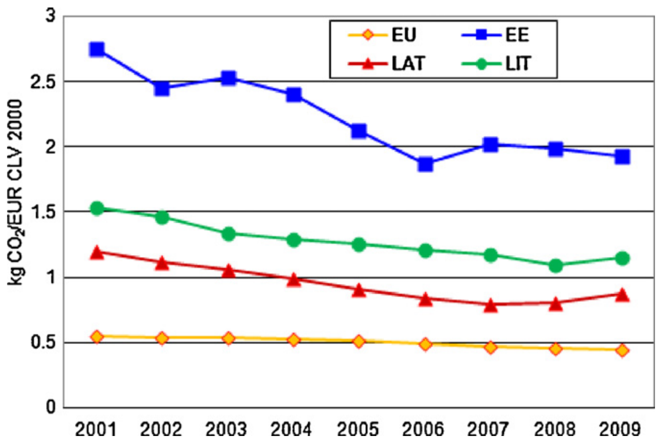


Fig. 13. GHG intensity of economy in 2001–2009.

production of one unit of economic output. The fewer amount of emissions per one euro are emitted, the more environment benign the country's economy is. In 2009, the GHG intensity of Estonia was 1.9, that of Latvia 0.9 and Lithuania 1.2 kg CO_2/EUR; it exceeds the EU average value (0.4 kg CO_2/EUR) 4.3, 2.0 and 2.6 times, accordingly [7,47–49]. At the same time the reduction in the GHG intensity of economy has improved the fastest in Estonia (33%), then in Lithuania (25%), Latvia (28%) and EU average (19%) compared to 2000, which fosters decoupling of emissions from the energy use and economic growth.

5.1. Estonia

In 2009, the total emissions of GHG in CO_2 equivalent were 9.8 million tons and without Land Use, the Land Use Change and Forestry (LULUCF), 16.84 million tons of CO_2 equivalet. The energy sector is the main source of GHG emissions in Estonia. In 2009, the energy sector contributed about 86% of total emissions, totalling 14.4 Mt CO_2 equiv. Compared to the base year 1990, the emissions were about 60% below that level (36.16 Mt CO_2 equiv.). Most of the energy sector emissions (97.7%) originate from fuel combustion and only 2.3% are contributed by fugitive emissions. The substantial amount of energy related emissions is caused by extensive consumption of fossil fuels for electricity and heat production. The share of oil shale, shale oil and shale gas combustion is about 67.5% of the energy sector total GHG emissions (Fig. 14) [50].

The share of oil shale (including secondary fuels made from oil shale: shale oil and shale gas) in electricity production is even larger totalling about 96% of the electricity production emissions in 2009 (see Fig. 15).

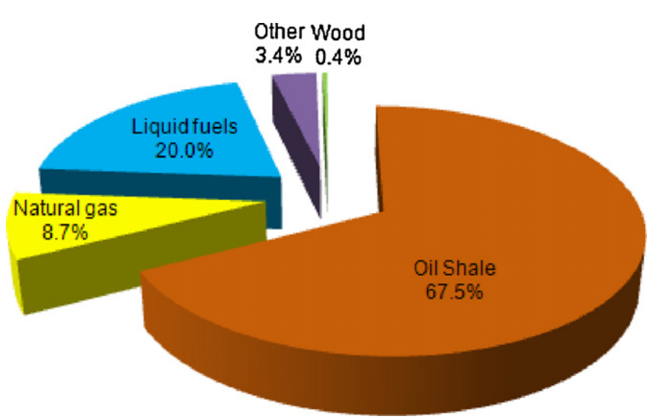


Fig. 14. GHG emissions by sources in 2009, %.

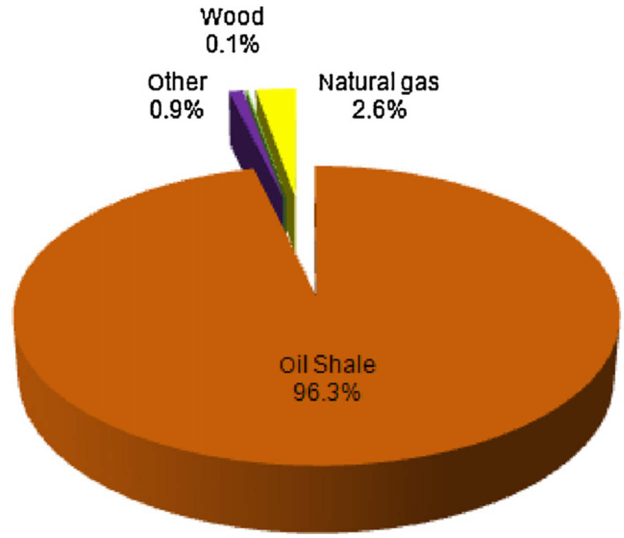


Fig. 15. GHG emissions by fuels in electricity production in 2009, %.

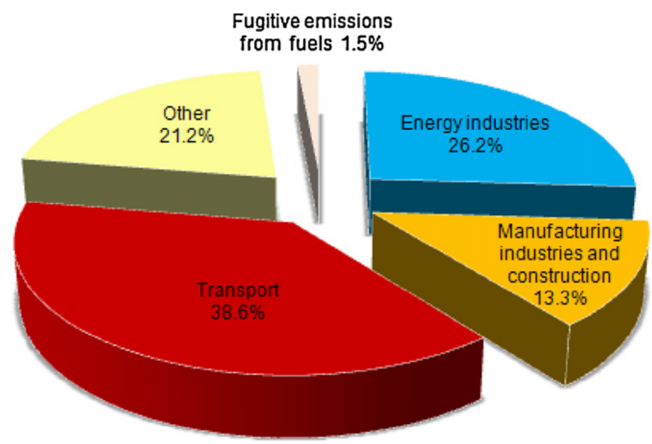


Fig. 16. Emissions from the Latvian energy sector in 2009.

5.2. Latvia

In Latvia the energy sector is the most significant source of GHG emissions too. In 2009, its share in total emissions made 67.4%, totalling 7.09 million tons of CO_2 equivalent. Compared to the base year (1990) the emissions decreased by approximately 62% from that level (18.82 Mt CO_2 equiv.). The largest share of GHG emissions in the energy sector comes from the transport sector (38.6%). 26.18% of energy related emissions originate from industry and 21.18% from other sectors (see Fig. 16).

The evaluation of energy sector key categories showed that the main source of CO_2 emissions is natural gas combustion in the heat and electricity plants. 15.86% of total GHG emissions in the country originate from these plants. The second key source of CO_2 emissions is consumption of diesel oil in the road transportation sector. The diesel oil vehicles have become more popular, because diesel oil is cheaper than gasoline [51].

5.3. Lithuania

In Lithuania, the total emissions of GHG were 17.86 million tons of CO_2 equivalent and without LULUCF 21.61 Mt CO_2 equiv. The energy sector is the most significant source of GHG emissions. In 2009, its share in total emissions comprised 66.5%, totalling 11.9 Mt of CO_2 equivalent. Compared to the base year 1990, the emissions in

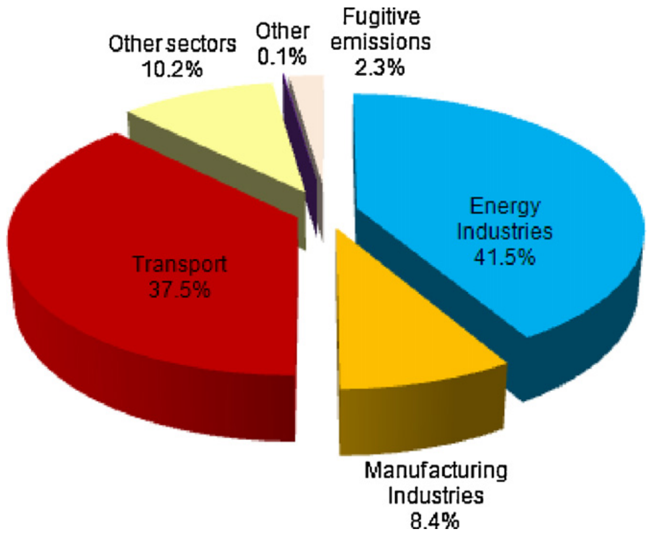


Fig. 17. Emissions from the Lithuanian energy sector in 2009, %.

energy sector have decreased by approximately 65% from that level (33.7 Mt of CO_2 equiv.). The largest share of GHG emissions in the energy sector comes from the transport (38.6%). 26.18% of energy related emissions originate from industries and 21.18% from other sectors (see Fig. 17) [52].

6. Greenhouse gas emissions reduction perspectives in the Baltic States

According to the National GHG Inventories, Estonia's, Latvian's and Lithuania's emissions decreased significantly between 1990 and 2009. Since then the annual emissions stayed more than 50% below the 1990 level. Current analyses and some earlier studies [53] give a clear indication that the Baltic States have no problems with meeting their Kyoto targets for 2008–2012 (see Fig. 18).

However, the EU has set several challenging climate and energy targets to be met by 2020. Amongst these there is a goal to reduce the GHG emissions in the EU member States by at least 20% below the 1990 level. The reduction of GHG emissions will be achieved through the integration of two mechanisms: the EU Emission Trading System (EU ETS) and country targets to the non-ETS sectors.

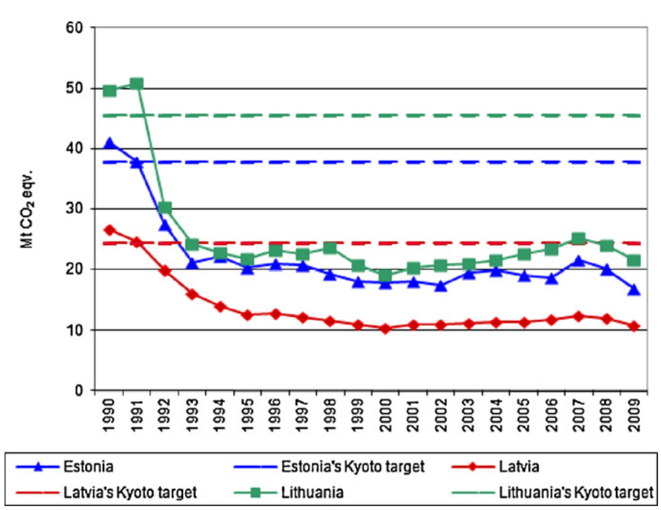


Fig. 18. Kyoto targets and trends of GHG emissions for Estonia, Latvia and Lithuania, Mt CO_2 equivalent.

In 2009 the European Parliament and the Council adopted a new Directive 2009/29/EC (amending the Directive 2003/87/EU) to improve and extend the greenhouse gas emission allowance trading scheme of the Community [54]. Nevertheless, when the revised directive governing the EU ETS was adopted in 2009, it was decided to introduce a harmonised EU-wide approach to the allocation of greenhouse gas emission allowances to the installations covered by the system. In particular, it was agreed that from the beginning of the ETS third phase (2013–2020), allowances should no longer be granted for free to power plants, which instead would have had to buy all their allowances through auctions (or in the secondary market).

However, to help modernize their electricity sector 10 new Member States were given the option (Article 10c of the Directive 2009/29/EC) of exempting these plants from the 'full auctioning' rule and continuing to allocate a limited number of emission allowances to power plants for free until 2019.

The eligibility criteria for exception are as follows:

- in 2007, the Member State had no connection to the electricity grid operated by the Union for the Coordination of Transmission of Electricity (UCTE) which existed then; or
- in 2007, the Member State had only one direct or indirect connection to the electricity grid operated by UCTE with a capacity of less than 400 MW; or
- in 2006, more than 30% of the electricity generation in the Member State concerned was produced from a single fossil fuel and the GDP per capita (at market prices) did not exceed 50% of the EU average.

Ten Member States are eligible since they meet one or more of the relevant criteria laid down in the revised EU ETS Directive. These States are: Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland and Romania.

The derogation from full auctioning for the power sector is optional. Eligible Member States need to decide whether they want to make use of this option or not. The Member State needs to decide for how many years and to what extent they want to make use of the derogation, as the Directive defines only maximum values in this regard. It must submit an application to the European Commission by 30 September 2011. Member States applying for the derogation need to take into account that the number of free allowances to be given to the power sector reduces the number of allowances they can sell at auction, thus lowering their national auctioning revenues.

The number of free emission allowances that may be handed out to power plants is limited. The revised ETS Directive stipulates that even when the derogation is granted, the level of free allocation in 2013 must not exceed 70% of the allowances needed to cover emissions for the supply of electricity to domestic consumers. In each year following 2013, this percentage has to decrease – the rules are set out in the Decision – and, in 2020, has to be 0%. Eligible Member States can decide to distribute fewer free emission allowances than the maximum amount permitted. Free allowances can be given only to power plants that were operational, or for which the investment process was physically initiated, by 31 December 2008. The use of the derogation is not allowed for newer power plants, in order to avoid undue distortion of competition on the European power market [55].

Decision 406/2009/EC lays down the minimum contribution of EU member States to meeting the GHG emission reduction commitment of the Community for the period from 2013 to 2020 for GHG emissions regulated by this decision, in the sectors covered by the ETS [5]. Here, Estonia, Latvia and Lithuania are amongst the 12 member States with an allowed increase of their non-ETS GHG emissions by 2020. The decision provides that a member state with

Table 2
Greenhouse gas emission targets of the sectors not covered by the EU ETS in 2020, Mt CO_2 equiv.

	2005	2009	2020
Total GHG emissions in Estonia	19.16	16.84	
Non-ETS	6.54	6.23	6.92
%	34.1	37.0	37.9
Total GHG emissions in Latvia	11.42	10.72	12.20
Non-ETS	8.57	8.23	10.01
%	75.0	76.8	82.1
Total GHG emissions in Lithuania	22.61	21.61	
Non-ETS	16.0	15.8	18.7
%	70.8	73.1	69.5

a positive limit (i.e., an increase of GHG emissions allowed) shall ensure that its GHG emissions in 2013 do not exceed a level defined by a linear trajectory, starting in 2009, on its average annual GHG emissions during 2008, 2009 and 2010.

The following formula (1) will be applied for calculating the 2020 annual emission allocations for sectors not covered by the EU ETS [56]:

$$(A–B–C–D–E) * (1 + F), \quad (1)$$

where A is the total emissions, excluding LULUCF in 2005[1]; B is the CO_2 emissions from the IPCC category domestic civil aviation (IPCC CRF 1.A.3) in 2005[2]; C is the verified 2005 emissions of installations by the ETS in 2005–2007 or verified 2007 emissions of installations by the ETS in 2007[3]; D is the 2005 emissions of installations that were included or excluded in the ETS in 2008–2012 due to an adjusted scope applied by Member State[4]; E is the verified 2005 emissions of installations opted out in 2005 and included in the ETS in 2008–2012[5]; F is the emission reduction percentage stated in the ESD (the Effort Sharing Decision – Article 3.2 of the Decision No. 4006/2009/EC)[6].

Estonia does not have a fixed national target for total national GHG emissions up to the year 2020. But, in relation to Estonia's commitments agreed at the EU level, Estonia's GHG emissions from the non-ETS sector should not increase over 11% to the year 2020 compared to 2005. In 2005 the total GHG emissions were 19.2 million tons of CO_2 equivalent, including 6.5 million tons of CO_2 equivalents from the non-ETS sector and 12.6 million tons of CO_2 equivalents from the ETS sector (Table 2). The share of non-ETS sector in the country's total emissions is rising (34% in 2005 and 37% in 2009). At the same time, the total GHG emissions are decreasing as a result of the measures implemented in the ETS sector [16].

Latvia's target is to limit the total national GHG emissions so that in 2020 they would not exceed 12.19 Mt CO_2 equiv. The target for GHG emissions in the non-ETS sector in 2020 is taken equal to the maximum limit +17% compared to 2005 allowed with Decision 406/2009/EC. The structure of Latvia's emissions has several peculiarities that should be taken into account when planning further measures of emission reduction. The ETS as an emission reducing mechanism covers only 23% of Latvia's GHG emissions, which is the second lowest share in the EU. And required limit +17% for non-ETS sector can be reached in case total GHG emissions will reduce by 56% compared to 1990. Such non-ETS sectors as the small-scale energy production, small industry, transport, agriculture, households and waste sector are of key importance in the reduction of overall emissions of Latvia. Moreover, 62% of emission structure in the abovementioned non-ETS sectors is comprised of sources in transport and agriculture that cannot be easily influenced. Other non-ETS sectors where the emissions are usually decreased by the measures for fuel changes environmentally friendly fuels – wood and natural gas are widely used already [17,57].

[1] *Source*: National inventory.
[2] *Source*: National inventory.
[3] *Source*: CITL.
[4] National allocation plans decisions for the second commitment period. Or data notified by the concerned Member State and agreed on by the Commission in the NAP process.
[5] Data notified by the concerned Member State.
[6] Annex II, of the Effort Sharing Decision ((ECD) Decicion No. .406/2009/EC).

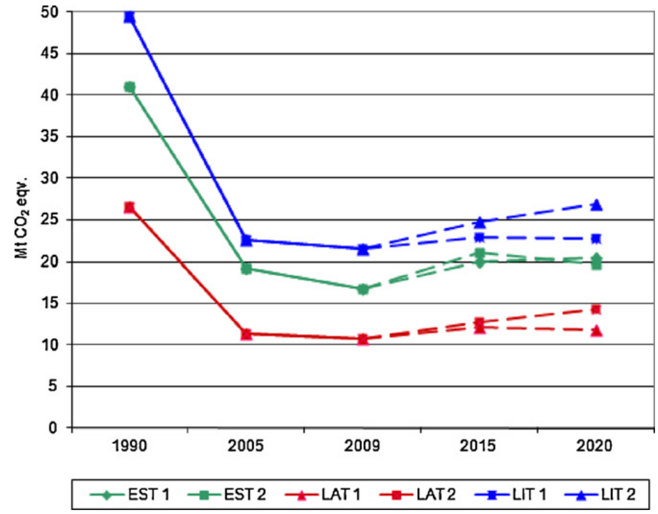


Fig. 19. Forecast of total GHG emissions in Estonia, Latvia and Lithuania by different scenarios for the years 2010–2020 (without LULUCF), Mt CO_2 equivalent.

Lithuania is permitted to increase its greenhouse gas emissions by no more than 15% until 2020, compared to the 2005 level, in the sectors that are not covered by the ETS [18]. In 2005, all sectors in Lithuania emitted 22.6 million tons of CO_2 equivalent: 6.6 million tons were emitted from the installations participating in the EU ETS whilst 16 million tons of CO_2 equivalent were emitted in the sectors not covered by the EU ETS. In 2009, 15.8 million tons of CO_2 equivalent were emitted in the sectors not covered by the EU ETS (the permissible amount until 2020 is 18.7 million tons of CO_2 equivalent).

It is not possible to calculate the combined (ETS + non-ETS) volumes of GHG emission for the Baltic States as at present the national obligations have been set for non-ETS sectors only whilst the national allocation plans for ETS sectors are still in the preparation phase. For assessing the ability of Estonia, Latvia and Lithuania to reach the 20% reduction target set by the EU Climate Package, several forecasts are considered. Fig. 19 presents the actual inventory data for 1990, 2005 and 2009, and forecast data for 2015 and 2020. The forecast data are given for two scenarios: the first one is based on the emission volumes calculated by the Technical University of Athens using the PRIMES model [58]. According to the modelling results, the GHG emissions from Estonia, Latvia and Lithuania will be 20.4, 18.9 and 22.7 million tons CO_2 equivalent, correspondingly (Scenario 1). The second scenario has been developed using the national forecasts from the Report pursuant to Article 3 (2) of Decision 280/2004/EC [59–61]. Here, the 'WM' (with measures) scenario has been selected. The WM scenario assumes that the policy and measures for GHG reduction have been implemented already.

The emissions calculated for this scenario are given in Table 3. The comparison of scenarios indicates that for Estonia the scenarios are quite similar, the difference being only 0.7 million tons CO_2 equivalent. At the same time, the difference for Latvia is 2.44 and for Lithuania 4.2 million tons CO_2 equivalent.

Table 3
GHG prognoses to 2020, Mt CO_2 equiv.

Scenarios	1990	2005	2009	2015	2020	Reduction compared to 1990, %
EST 1	41.1	19.2	16.8	20.0	20.4	50
EST 2	41.1	19.2	16.8	21.1	19.7	52
LAT 1	26.6	11.4	10.7	12.2	11.8	56
LAT 2	26.6	11.4	10.7	12.8	14.2	46
LIT 1	49.6	22.6	21.6	22.9	22.7	54
LIT 2	49.6	22.6	21.6	24.7	26.9	46

Source of scenarios 1 [58]. Source of the scenario Estonia 2 [59]. Source of the scenario Latvia 2 [60]. Source of the scenario Lithuania 2 [61].

7. Conclusions

The energy sector is the main contributor to GHG emissions in Europe and the Baltic States as well. The national energy sectors in the Baltic countries differ in many aspects, particularly in terms of energy resources.

The energy sectors of the three Baltic countries were analysed from the point of energy efficiency and use of renewable energy sources. All the targets set in the EU Energy and Climate Package were evaluated in the current paper. The research was mainly focused on reaching the GHG reduction target.

Based on the GHG emission forecasts described in the article, it could be concluded that Estonia, Latvia and Lithuania can meet the targets set by the EU Climate and Energy Package for Member States. However, it would be a huge challenge for all the Baltic States.

Estonia has to find a solution for reducing the high share of oil shale in the fuel consumption. Today oil shale contributes almost 68% of GHG emissions from the energy sector.

The costs of emission reduction in Latvia are amongst the highest in the EU. Significant amount of financing is required to support the measures for emission reduction in non-ETS sector, including support to the deployment of renewable energy sources, which cannot compete with the imported fossil energy.

The main obstacles for GHG emission reduction in Lithuania are the lack of measures for GHG emission reduction. The GHG emission reduction policies in Lithuania are mainly targeted at the supply sector and oriented on the huge and expensive supply-side measures. There are no sufficient incentives to promote the use of renewables since the Lithuanian Government is committed to building a new nuclear power plant.

According to the analysed forecasts the GHG emission reduction will be much higher than the EU average targets: in Estonia for 50–52%, Latvia 46–56 and Lithuania 46–54% whilst the required EU average is 20%.

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